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THE UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICANT: BRUNNER ET AL - 1 (CPA) EXAMINER: C. A. BROWN

SERIAL NO: 09/425,694 GROUP: 1765

FILED: OCTOBER 22, 1999

TITLE: PROCESS FOR THE WET TREATMENT OF SEMICONDUCTOR WAFERS

ATTN: BOX FEE AMENDMENT  
Assistant Commissioner of Patents  
Washington, D.C. 20231

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RESPONSE TO NONFINAL OFFICE ACTION

This is in response to the NonFinal Office Action dated April 10, 2002, with the time for reply having been extended for one month or until AUGUST 10, 2002.

REMARKS

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AUG 20 2002  
TC 1700

Reconsideration of this patent application is respectfully requested in view of the following remarks.

The Patent Examiner has rejected claims 1 to 11 as being unpatentable under 35 U.S.C. 103 over Pirooz EP 701,275 in view

of newly cited *Verhaverbeke* U.S. Patent No. 6,132,522. (It is respectfully submitted that *Pirooz* is not EP0731498A2 which is *Fukuzawa*).

Neither *Pirooz*, nor *Verhaverbeke*, teach or suggest the claimed three steps of firstly treating the semiconductor wafers in a bath with an aqueous HF solution; only containing HF;

then treating the semiconductor wafers in a bath with an aqueous O<sub>3</sub> solution; only containing O<sub>3</sub>,; and

then treating the semiconductor wafers in a bath with an aqueous HCl solution; only containing HCl;

whereby these treatment steps form a treatment sequence B<sub>2</sub>, which avoids rinsing with water or another treatment liquid and the addition of fresh water or other liquids to the treatment baths.

*Pirooz et al.* (EP-701 275) disclose a cleaning process for semiconductor wafers which comprises subjecting the wafers to a

sequence of the following treatment agents (Please see column 2, lines 48 to column 3, line 34):

Substances which are optionally present only are inclosed into brackets.

Step A:

HF:H<sub>2</sub>O + [HCl]      or      HF:H<sub>2</sub>O +- [H<sub>2</sub>O<sub>2</sub>]      or      HF:H<sub>2</sub>O + [O<sub>3</sub>]

Step B:

Rinsing with H<sub>2</sub>O

Step C:

O<sub>3</sub>:H<sub>2</sub>O + [HCl]      or      O<sub>3</sub>:H<sub>2</sub>O + [HNO<sub>3</sub>]

Step D:

Drying **or**      Rinsing with H<sub>2</sub>O

The newly cited reference *Verhaverbeke et al* (US-6,132,522) teaches, inter alia, a sequence of the following treatment agents (please see column 9, lines 34-42):

Step 1:

HF:H<sub>2</sub>O

Step 2:

H<sub>2</sub>O<sub>2</sub>:H<sub>2</sub>O

Step 3:

H<sub>2</sub>O<sub>2</sub>:H<sub>2</sub>O:NH<sub>4</sub>OH

In addition, according to *Verhaverbeke et al.* rinsing of the wafers between steps 1 to 3 is not required.

The present invention claims a procedure comprising a treatment with the following sequence of treatment agents:

Step i:

HF:H<sub>2</sub>O + [HCl] + [surfactant]

Step ii:

O<sub>3</sub>:H<sub>2</sub>O + [HF]

Step iii:

HCl:H<sub>2</sub>O + [O<sub>3</sub>]

Also any rinsing step between steps i to iii is excluded.

Since the last mentioned feature is a crucial requirement of the present invention, *Verhaverbeke et al.* clearly qualifies to be considered as the closest prior art reference.

A comparison between *Verhaverbeke et al.* and the present invention reveals a significant difference between steps 2 and 3 (*Verhaverbeke*) and steps ii and iii (Invention) respectively. Step 2 and step ii differ in that  $\text{H}_2\text{O}_2:\text{H}_2\text{O}$  is used instead of  $\text{O}_3:\text{H}_2\text{O}$  and step 3 and step iii differ in that  $\text{H}_2\text{O}_2:\text{H}_2\text{O}:\text{NH}_4\text{OH}$  is used instead of  $\text{HCl}:\text{H}_2\text{O}$ .

If the present invention is further compared with *Pirooz et al.*, two other differences can be found. *Pirooz et al.* teach in contrast to both the present invention and *Verhaverbeke et al.* a rinsing step with water (step B) and *Pirooz et al.* discloses a step C comprising a treatment with either  $\text{O}_3:\text{H}_2\text{O} + [\text{HCl}]$  or  $\text{O}_3:\text{H}_2\text{O} + [\text{HNO}_3]$ , whereas according to the present invention **two subsequent steps** are necessary, i.e. step ii (a treatment with

$O_3:H_2O+[HF]$ ) and then step iii (a treatment with  $HCl:H_2O + [O_3]$ )).

*Verhaverbeke* is not combinable with *Pirooz* for the following reasons.

The newly cited *Verhaverbeke* U.S. Patent No. 6,132,522 in column 3 in lines 9 to 22 discloses wet processing methods useful in the manufacture of electronic component precursors, such as semiconductor wafers and flat panels, used in integrated circuits. These methods can be used for the cleaning, stripping, and/or etching of such electronic component precursors.

It has been discovered that eliminating the DI rinse between each chemical treatment step minimizes precipitation of the silica, metal, and/or oxide precipitates. In contrast to the wet processing methodologies available in the art, which focus on rinsing the electronic component precursors with DI water between each chemical treatment step, the process eliminates the need for the DI rinse by using a sequential chemical methodology.

In column 9 in lines 7 to 28 *Verhaverbeke* discloses that in

sequential chemical processes, the DI rinse between each chemical step is not required. In a sequential chemical process the vessel fills with DI water through valve 31, conditioning of temperature and flow take place, the first reactive chemical process fluid is injected into DI water stream flowing in 9 via injection lines (i.e., 17, 15). The first reactive chemical flows into the vessel through valve 31 into the vessel. The soak starts by closing valve 31. During the soak, conditioning of flow and temperature of DI water occurs through the DI bypass 45, by opening valve 47. Conditioning occurs only during the soak. At the end of the soak, the valves positions switch (i.e., valve 31 opens and 47 closes) and injection of the next reactive chemical process fluid occurs immediately through injection port 19 so that next reactive chemical process fluid directly displaces the previous reactive chemical process fluid (i.e., no DI water is used to displace chemical in the vessel). These steps or similar steps known to persons skilled in the art may be repeated until the electronic component precursors are properly treated with the appropriate chemicals. Following the chemical treatment steps, the electronic component precursors may be dried as discussed above.

In column 10 in lines 15 to 45, *Verhaverbeke* discloses that the methods of this reference may be used where only one set of sequential chemical treatment occurs. For example, where the chemical treatment recipe is sulfuric acid (mixed with either peroxide or ozone)/HF/SCI/SC2, this is followed by drying. Traditionally, a DI water rinse is performed between each chemical treatment step. According to the methods of this reference, all of the DI water rinses may be eliminated or maybe only one or two rinses may be done between some, but not all, of the chemical treatment steps regardless of the wet processing technique employed.

As previously stated, traditional wet processing techniques use a DI water rinse between each chemical treatment step to prevent the chemicals from mixing with each other and to prevent contamination of one reactive chemical process fluid with another. *Verhaverbeke* departs from this principal, by not performing a DI water rinse between each chemical treatment step, while still obtaining good process performance and leading to overall cost efficiencies. However, in practicing the process of *Verhaverbeke*, it is desirable to exchange the chemical solutions



regularly to achieve reproducible processing. It is particularly preferred that the chemicals be exchanged after one use, while traditionally, chemicals are used for extended use. Adequate performance may be obtained with extended use by spiking (i.e., adding chemical to the second bath) to maintain a relatively constant concentration and pH. This, however, is still more efficient than the traditional techniques that use a DI water rinse between each chemical treatment step. A person skilled in the art would therefore never combine the teaching of *Verhaverbeke* (devoid of water rinsing) with *Pirooz* (employs water rinsing).

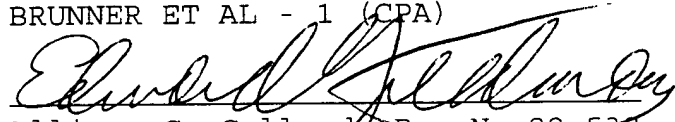
It is clearly non-obvious to replace a single step treatment taught by a prior art reference as a treatment which can be realized by choosing one of two possibilities by a two step treatment requiring the two possibilities in a specific order. Moreover, it still must be emphasized that *Pirooz et al.* teach intermediate rinsing with water which is contradictory to the teaching of *Verhaverbeke et al.* Hence any attempt to combine these references would constitute a radical reconstruction of the prior art which is impermissible according to 35 U.S.C. 103.

Accordingly, both references absolutely cannot be combined so as to disclose the claimed invention.

Thus the claims must be considered as being non-obvious under 35 U.S.C. 103 with respect to the prior art applied by the Patent Examiner. A prompt notification of allowability is respectfully requested.

Respectfully submitted,

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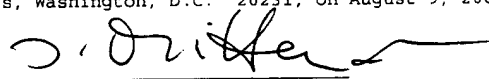
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Enclosures: (1) Response to NonFinal Office Action;  
(2) Copy Petition One Month Extension of Time;  
(3) Check for \$110.00.

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as first class mail in an envelope addressed to: Assistant Commissioner of Patents, Washington, D.C. 20231, on August 9, 2002.



Ingrid Mittendorf